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BUILDING A FULL-SIZE GLIDER

By F. J. Camm

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By F. J. Camm.

I can imagine the reader considering that the construction of a real glider, one in which he may make comparatively short flights, controlling the glider himself, to be the work of a skilled engineer. I can also conceive the plethora of questions which will run through his mind. How much will it cost? Is it dangerous? Is a special ground necessary? Does it require considerable skill? How can I transport it? How is it launched? How long will it take to build? And so on. So I want first of all to dispel doubts and explain to the reader that anyone who can use a plane, saw, hammer, and chisel can build the glider, for all brazed and turned parts have been omitted, as will be seen from the drawings, and secondly, that it takes a surprisingly short time to learn to glide, for the "air sense" is quickly acquired once a few towed flights have been indulged in. It is always advisable to get a few assistants to tow the glider into the air first of all, and to maintain their hold on the tow rope, for this avoids wrecking the glider while the simple fundamentals of the use of the control stick are being acquired. For these towed flights a length of rope is attached to each end inter-strut at the leading edge of the bottom wing, and with two assistants each side, carefully

*From "The Air League Bulletin," of the Air League of the British Empire, London.

instructed to pull together and to pay out the rope as the glider ascends, the machine will rise into the air at almost a walking pace even on a still day. If a wind, however slight, is blowing, the glider should be towed against it so that a quick take-off is obtained. Once in the air the pilot will soon gain experience, and after a very little practice, may instruct those operating the tow ropes to release them, so that he will thus enjoy free glides. Until this experience is gained the tow rope assistants should manipulate their ropes to keep the glider on an even keel and to correct mistakes of the pilot. From this point of view, a tow rope may be attached to the tail position so that an assistant may correct any tendency to dive.

It is necessary to point out that if a hill with a moderate gradient and free from trees is available, much longer glides can be indulged in, but in any case it will always be necessary to tow the glider off. Where a hill is available for gliding (nearly always permission can be obtained from the owners of private estates when public ground is unsuitable - and private ground avoids crowds!), it is necessary to choose a day when the wind is blowing <u>up</u> the hill if glides of reasonable duration are to be made. Of course, the glider is not so efficient as some of the gliders used at present in France and Germany, but it is sufficiently efficient and strong for ordinary gliding. Indeed, the glider shown in the accompanying drawings and plates

has suffered no more serious damage than a buckled wheel. So much, then, regarding the ability required to glide. Now as to transport. The glider is extremely portable, being made in four sections, the central cellule containing the pilot's seat, the two end wing boxes, and the tail portion. The whole glider may therefore be dismantled when the gliding ground is situated some distance from the shed in which it is stored, and thus easily packed and wheeled to the gliding venue. This method of erection has the added advantage that the glider can be stored in a very small space, and as the dismantling process merely entails the unlocking of a few wire strainers and wing nuts, it will readily be perceived that it does not occupy a lot of time, and it may be just as quickly assembled.

Again, should the glider become damaged, it is cheaper and easier to repair a section. It took four of us a month of evenings to build the glider, at a total cost of five pounds. Each of us had a special job - one making fittings, one sawing, one planing, and one assembling and, quite apart from the pleasant anticipation of many pleasant rides in the air, we thoroughly enjoyed building the glider. It has a fascination all its own, and none of us met with the slightest mishap during gliding. A camping holiday with a glider is remarkably enjoyable, and is the ideal way of acquiring skill. At first, of course, only very short glides will be obtained, but as experience is gained the glides will become longer, and gradually bank turns into the

wind, soaring and climbing may be indulged in.

Well, I hope I have dispelled the reader's doubts and inspired him with enthusiasm, for with the remainder of my limited space, I must deal with the general details and construction of the glider. First, some general details. The glider, as will be seen, is really a modified Chanute type, with interconnected ailerons which are normally set at a slight negative angle to give lateral stability. The rudder is fixed, and therefore constitutes a vane for stabilizing purposes. The tail is of the non-lifting type, control being by means of the ailerons and tail elevators. A fore-and-aft movement of the control lever operates the elevators (forward for descending, and backward for ascending) and sideways operates the ailerons. The control of these is instinctive, that is to say, for a right-hand bank turn the control lever is moved to the right and vice-versa.

I mentioned that the ailerons were interconnected; this merely means that when one aileron is up the other is down, so obtaining twice the effect and making the glider very responsive to the control lever. The pilot's seat, it may here be mentioned, is adjustable fore and aft, so that the center of gravity may be adjusted.

All of the fittings are cut from 18 gauge sheet steel, excepting the tube joints for the wings and tail portion, which are of 20 gauge steel tube. The axle is of steel tubing $1\frac{1}{2}$ inches diameter by 20 gauge, and is plugged solid with ash.

Unbleached calico is used for covering the wings, air and water-proofed with varnish and linseed oil mixed in the proportion 3 parts varnish to 1 linseed oil. Bowden cable of the motorcycle clutch control type is used for the controls. This should be well soldered before it is cut, otherwise the strands will fly out of lay and render the cable useless. Bracing wire for the wings is 18 gauge steel piano wire, 16 gauge piano wire being used for the chassis. Lightness being of great importance (the complete glider weighed only 80 pounds), silver spruce is used for most of the framework, with the exception of the bottom members of the fuselage and the skids.

Before actually commencing construction, it is wise thoroughly to study the drawings in conjunction with the photographs to obtain a good general idea of the job in hand. So that this article might be confined to reasonable space, all of the important dimensions have been given on the drawing, so that I shall make no reference to sizes, but confine my remarks to actual construction. A scale is constructed at the top of the sheet, so that when in doubt as to size, reference can be made to this.

Figs. 1, 2 and 3 show the glider in side and front elevations and plan view respectively, all important dimensions being clearly marked. The first part to construct is the central cellule, and the best method of attack is to copy the side elevation full-size upon the floor of the workshop, and to pin blocks down on each side of the lines representing the frame members.

The bent members can then be sprung between these blocks and the fittings, cross members and bracing wires assembled with them thus held down. The ash skids should, of course, be well soaked in boiling water for an hour or so prior to being sprung between the blocks, and they should be left so held down for several days and frequently saturated during this period. The curve of the skids as drawn on the floor should be made greater than that shown in the drawing, to allow for the spring back of the ash when the assembly is removed from the template.

With the two sides of the central cellule complete, the members may be put in and the rail to carry the adjustable pilot's seat (see Fig. 12). Next fit the control lever, clearly shown in Fig. 15. This, it must be remembered, has two king-posts attached to it, one on each side, as clearly seen in Plate 5, but omitted for clearness, on the drawing. These two king-posts of course carry the wires which control the movement of the tail elevators.

The position of the tube socket joint which connects the tail portion to the central cellule is shown in the side elevation (Fig. 1). These tubular sockets are permanently fixed to the bearers of the central cellule, and project sufficiently to allow the tail part to socket on. When the tail bearers are pressed tightly home into the sockets, two holes are drilled in each socket so that a bolt and wing nut may be used to lock or unlock the joint.

This form of socket joint is also used to secure the two end wing sections, as sketched in Fig. 4. An alternative joint here, and one which would serve just as well, would be to bolt right-angled brackets on the top of the top wings and the bottom of the bottom wings, in such a position that the ends of the wing butt up close, and to secure them by means of bolts and wing nuts passing through the projections.

The joint at the tail end of the fuselage is drawn in Fig. 9; it is really self-explanatory, it being only necessary to instruct the reader to secure the socket to the top members first, otherwise they may be bowed out of true.

The cross members of the fuselage are assembled in the manner shown in Fig. 10, suitable lugs for the bracing wires being taken off the bolls, or cut as one with the fishplates.

Two rear skids are required - one for each of the bottom members. They may be bent from stout canes and lashed to the members as seen in Fig. 22. Their main purpose is to support the tail off the ground, and to prevent damage to it when landing after a glide. The seat, the slidable adjustment of which is clearly shown in Fig. 12, should be as light as possible. I used a 1/4 inch three-ply semicircular bottom, with a piece of 18 gauge aluminum as a back, and an American cloth hair-stuffed cushion.

The control lever, to which I have referred earlier, is detailed in Figs. 15 to 17. It will be seen that it rocks forward

and backward for elevator control, and is pivoted in the center for the sideways movement which controls the elevators. The control is instinctive, that is to say, when the control lever is moved to the left the glider will bank to the left, and vice-versa, and similarly a backward movement controls ascent and a forward movement, descent. Double pulleys are fixed on the top wing at the points shown in Fig. 2, and the control wire passes direct from the lever, over one pulley to the bottom of the aileron king-post on each side, locking the control lever truly central in some definite way, and wedging the ailerons so that they have a slight negative angle while the wires are being fixed. It is wise to interpose a wire strainer in each wire so that stretch can be taken up and the normal position of the lever adjusted. Having gotten these two wires into position, pass one length of wire from the top of the king-post, over the second pulley on each side and so to the top of the second king-post. Now adjust the tension by means of the two wire strainers until the ailerons work freely but without backlash. It will be noted that when one aileron is up the other is down. The control wires to the two king-posts on the elevators are now attached, again locking the lever in its neutral position and wedging the tail elevators. The top of each elevator king-post is connected to the bottom of the control lever king-post, and conversely the bottom of each tail king-post is secured to the top of each control lever king-post. The hinges, by the way, for the eleva-

tors and ailerons should be of good quality steel, and must be bolted to the spars. A bicycle handle-bar grip may be used in place of the wooden knob on the control lever. The king-posts are secured as shown in Fig. 11, glue and screws holding the joint.

If some small airplane wire strainers are not available, some perfectly satisfactory strainers may be made up in the manner shown in Fig. 20, from sheet steel and good quality motorcycle spokes. These latter, as a fact, were used in the glider shown in the plates.

Now regarding the wheels and suspension. A steel tube is used for this, plugged solid with ash or other hard wood, and the stub axle ends are taper-pinned into steel plugs about 4 inches long hammered into the ends of the axle tube. Large steel washers are cross taper-pinned into place to locate the rubber suspension, as shown in Figs. 18 and 19, where also will be noted the ash chocks screwed and glued to the skids to carry the suspension. The wheels may be light 26-inch motorcycle wheels, or 15-inch motor scooter wheels, which are readily obtainable second-hand from any motorcycle garage. The suspension should contain sufficient rubber to prevent undue flexure; the maximum deflection on landing should not be more than $2\frac{1}{2}$ inches. At the same time it should not be so stiff that breakage occurs.

The wings, aerodynamically, are inefficient, but I fear the reader would scarcely care to go to the trouble of building a

wing of proper section, unless he anticipates glides of many hours' duration. Accordingly, the construction is of the simplest form compatible with reasonable efficiency. They are plan-braced, which is really necessary to maintain such a light structure true in form (see Fig. 7 for details of the wing bracing lugs), the end ribs being of T-section to resist the pull of the fabric, and the aileron abutments being strengthened in the manner illustrated by Fig. 14.

The trailing edge is flexible, the wire being secured to each rib as sketched in Fig. 6. The wire before covering, of course, will be perfectly straight; the scallops form naturally when the fabric is stitched over it.

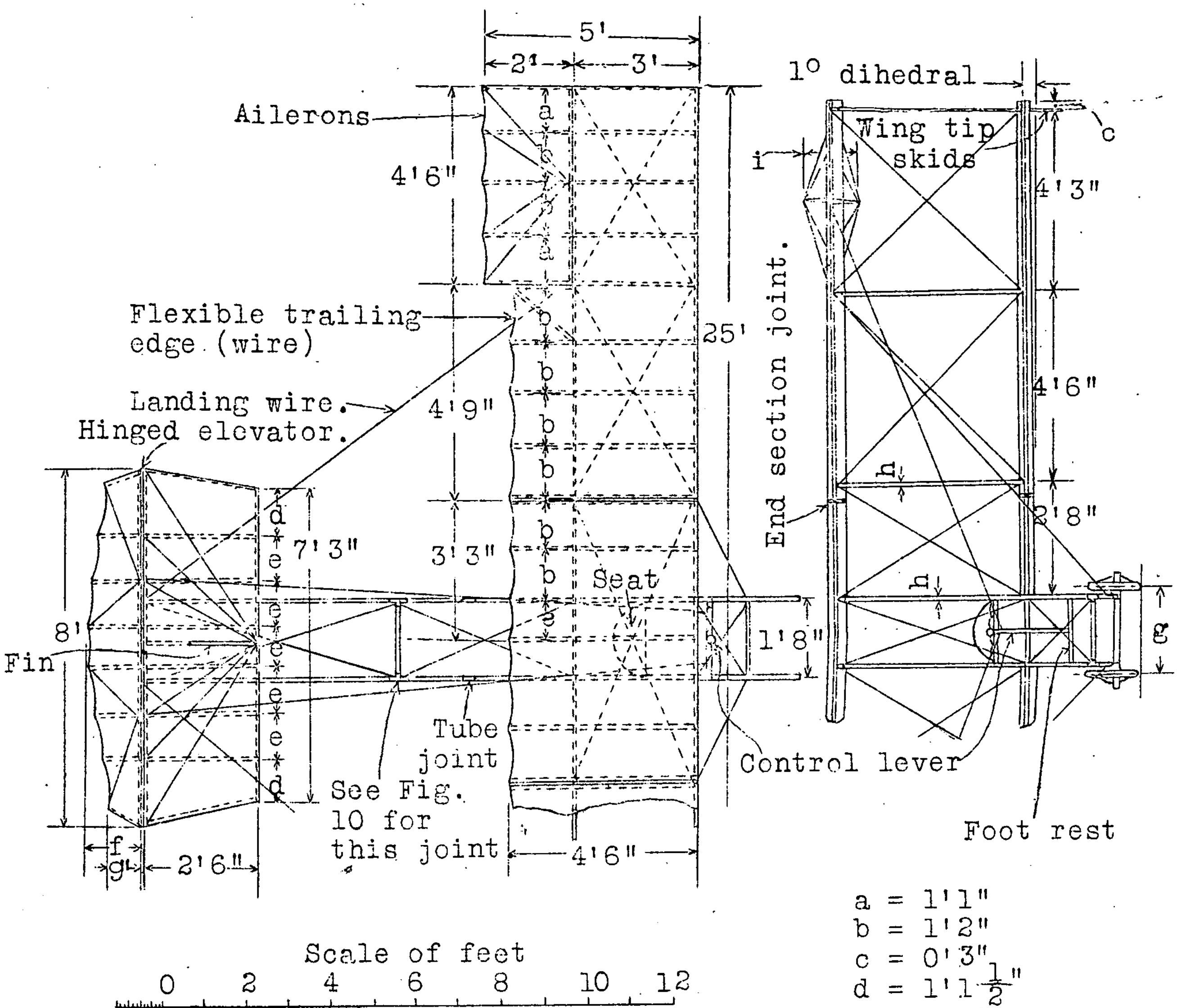
A section of the wings, showing the form of construction adopted, is given by Fig. 21, which needs no description, as the construction is self-evident. It is important that the rear wing spar be pocketed with fabric, as clearly shown in Plate 2. The ribs are steam-cambered to a template, and great care should be expended in getting all of them identical. They are glued and screwed to the wing spars. Before covering is commenced, the inter-strut sockets must be made and secured to the spars. They consist of steel tubing slit down a certain distance with a hack saw and spread open to form the bracing lugs (see Fig. 5). The tubing should be of such a size that the inter-struts drive fairly tightly into them. The inter-struts themselves, after leaving the sockets are streamlined off to the section shown by

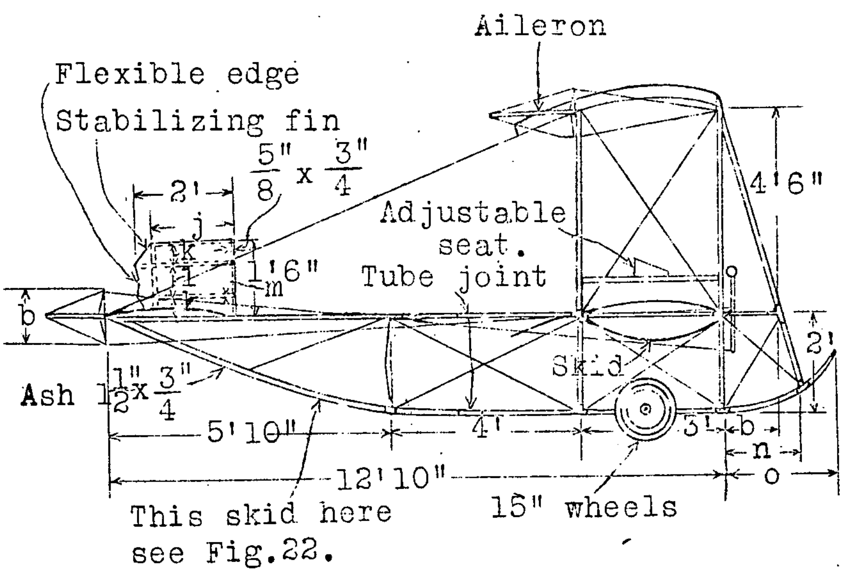
Fig. 8. Two somewhat half-elliptic skids are attached to the lower ends of the end inter-struts, as depicted in Fig. 13, by means of a simple clip and bolt.

The fabric should be stretched over the wings from end to end and secured by means of strips of cane. It is then tacked along under the leading edge and stitched over the trailing edge, carefully pulling out all wrinkles and stretching the fabric as tightly as possible.

Additionally, the fabric is stitched over and over to each rib, so that it does not lift away from the ribs when the glider is in flight. When the wings are covered they should be given two thin coats of the proofing already recommended, and left to dry.

By the way, it will be noted that a slight dihedral angle (see Fig. 2) is given to the bottom wing only, and therefore the inter-struts should vary in length to provide for this. The tail and bottom main wing is secured to the fuselage in the manner shown in Fig. 23. The tail and rudder present no special difficulty. The rudder is detailed in Figs. 24 and 25, and the tail is assembled in the manner already described for the main wings. It only remains to assemble the wings, etc., to the fuselage and to brace up truly by means of the wire strainers, adjusting the tension of each wire by means of the strainers, so that the leading and trailing edges are in alignment. The bracing wire is passed through and bent back over short pieces of copper tubing, as clearly shown.





a = 1'1"
b = 1'2"
c = 0'3"
d = 1'1$\frac{1}{2}$"
e = 1'0"
f = 1'3"
g = 2'2"
h = 1$\frac{1}{2}$" x $\frac{3}{4}$"
i = 1'4"
j = 1'9"
k = 0'5"
l = 0'8"
m = $\frac{1}{8}$" x $\frac{5}{8}$"
n = 1'6"
o = 2'4"

Plate V
Figs.1,2,3. Assembly of glider.

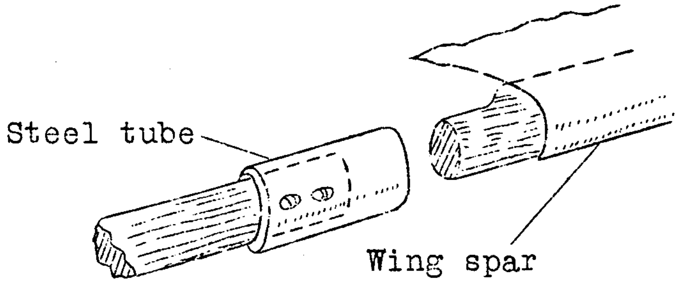


Fig.4

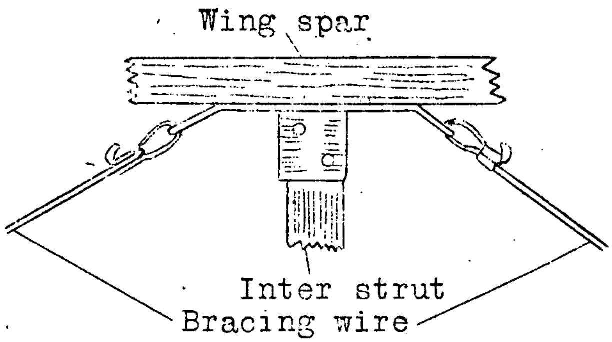


Fig.5

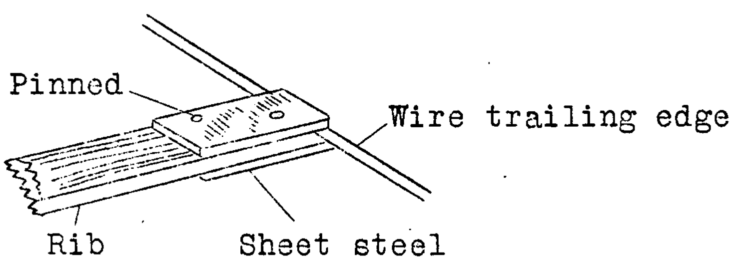


Fig.6

Details not to scale

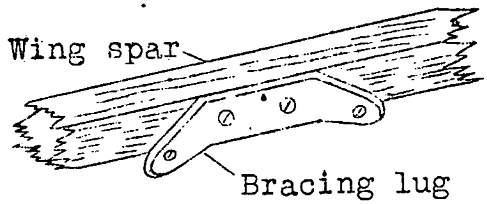
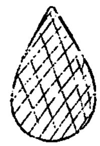


Fig.7



Section of struts

Fig.8

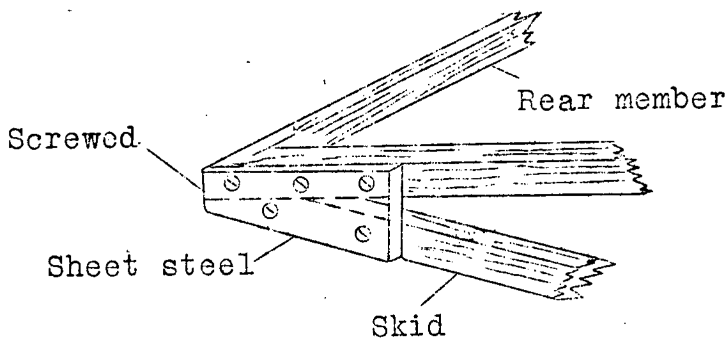


Fig.9

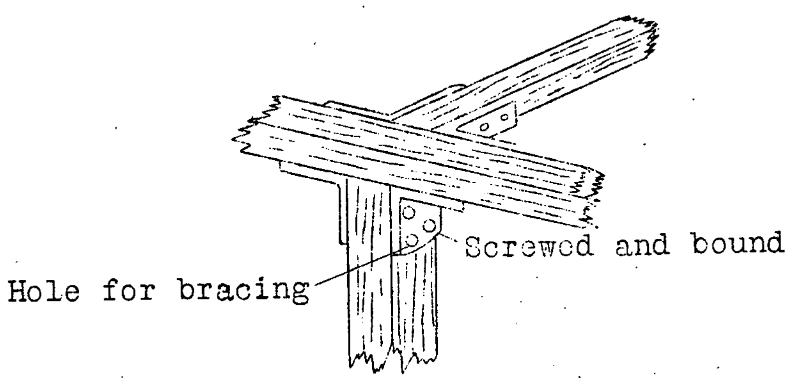


Fig.10

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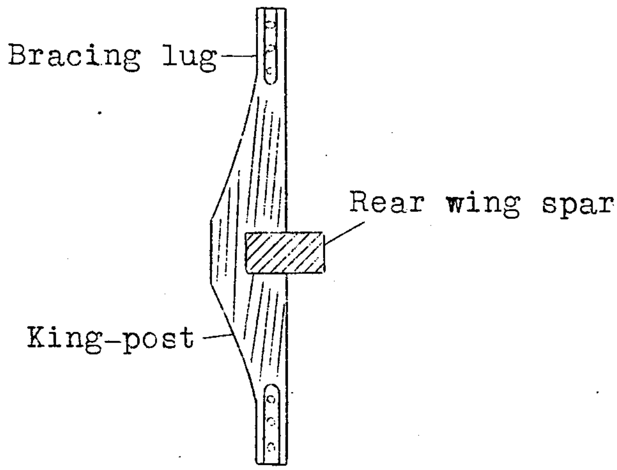

Fig,11

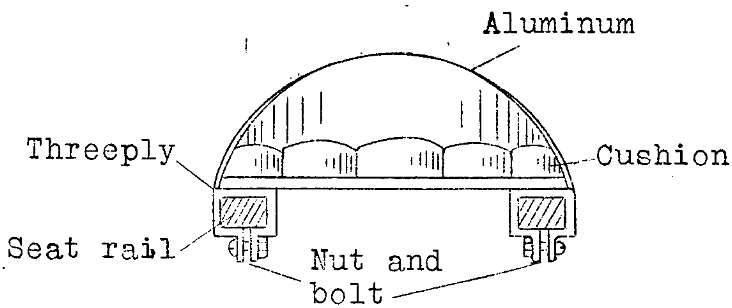

Fig.12

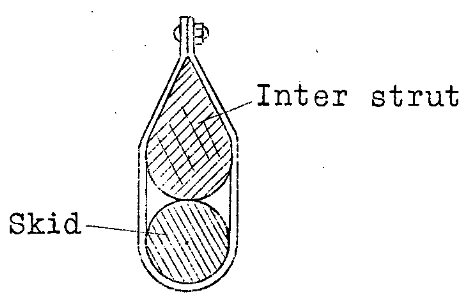

Fig.13

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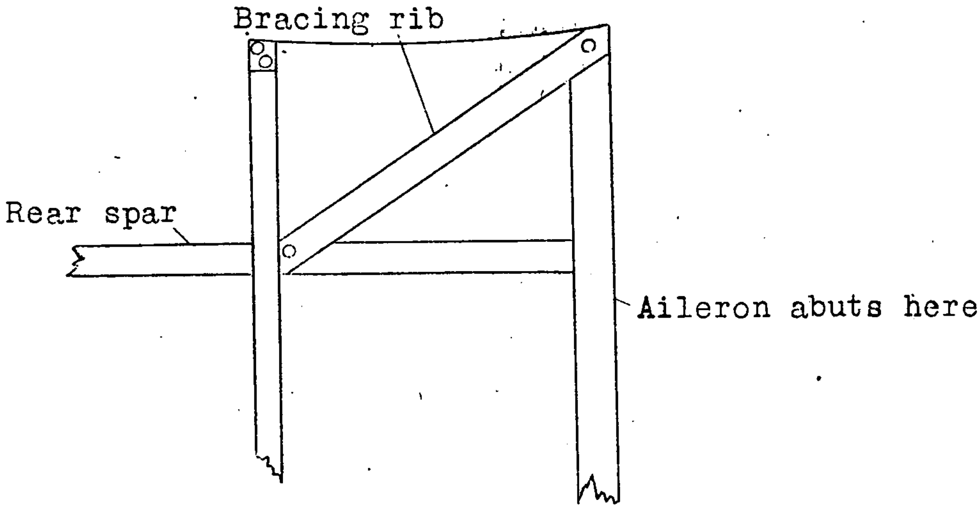

Fig.14

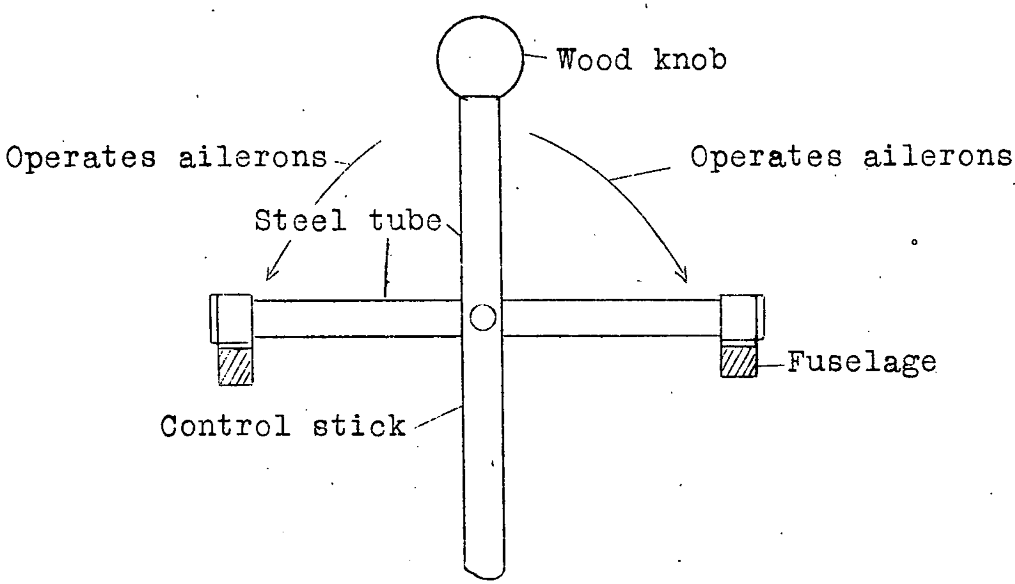

Fig.15

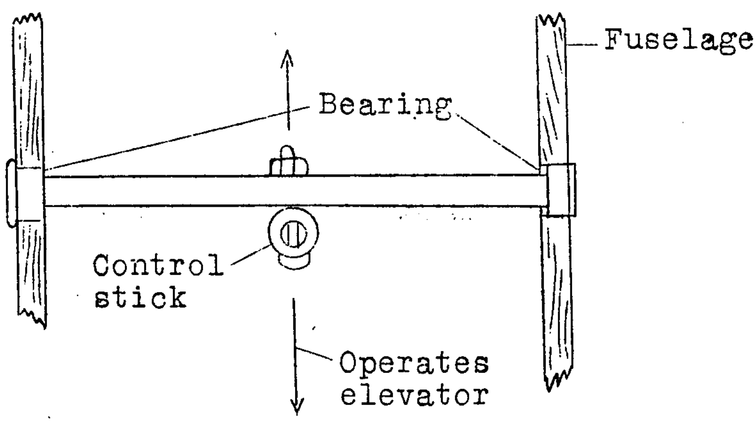

Fig.16

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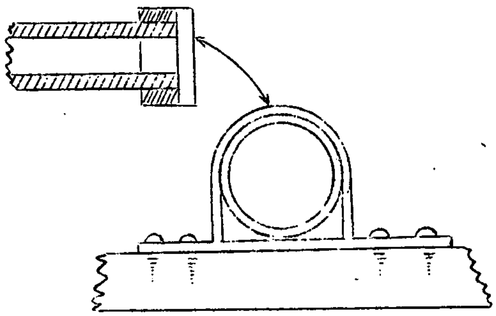

Control bearings

Fig.17

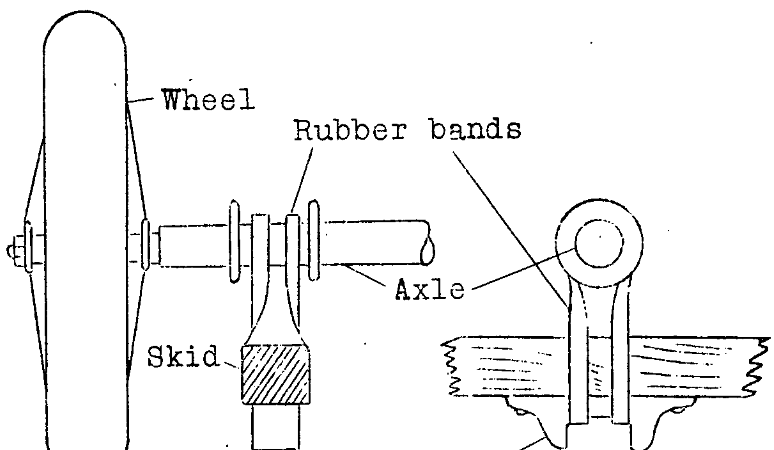

Fig.18 Fig.19

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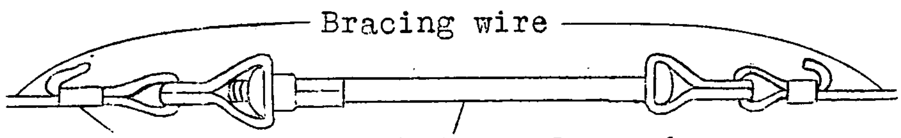

Fig.20

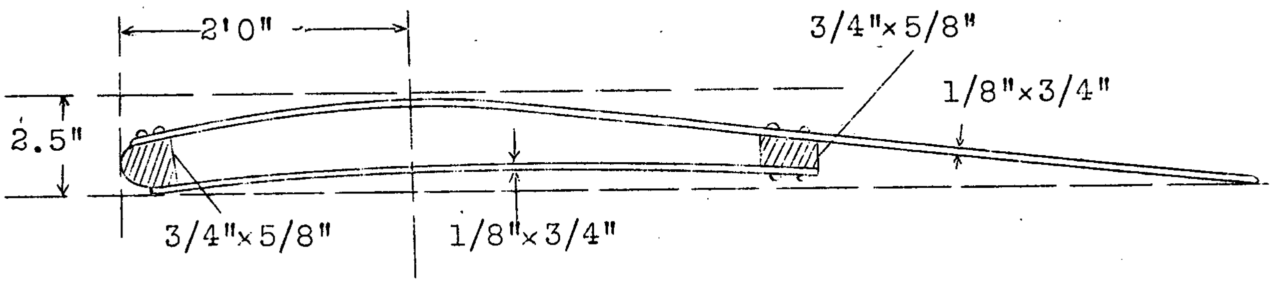

Fig.21

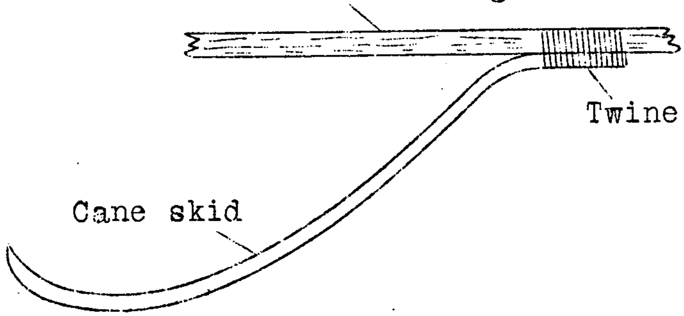

Fig.22

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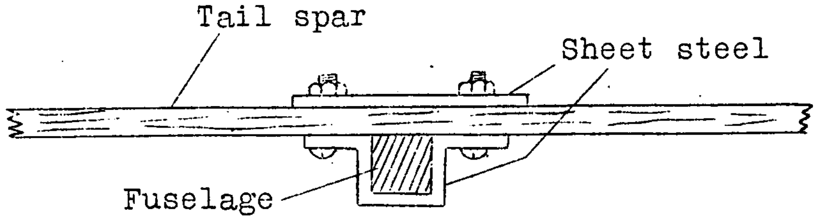


Fig.23

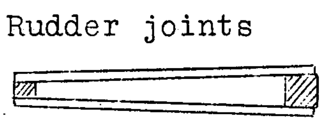


Fig.24

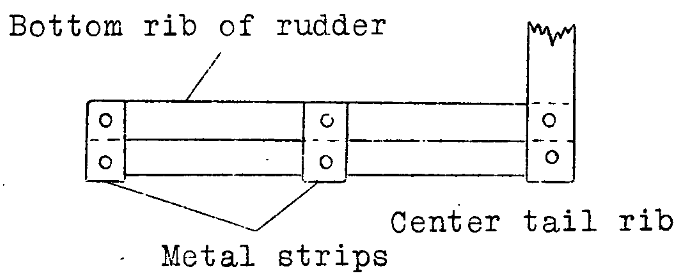


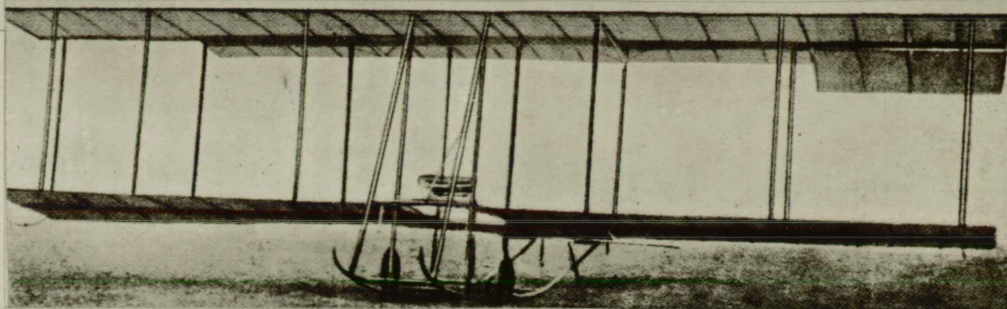
Fig.25

Details not to scale

Plate 1

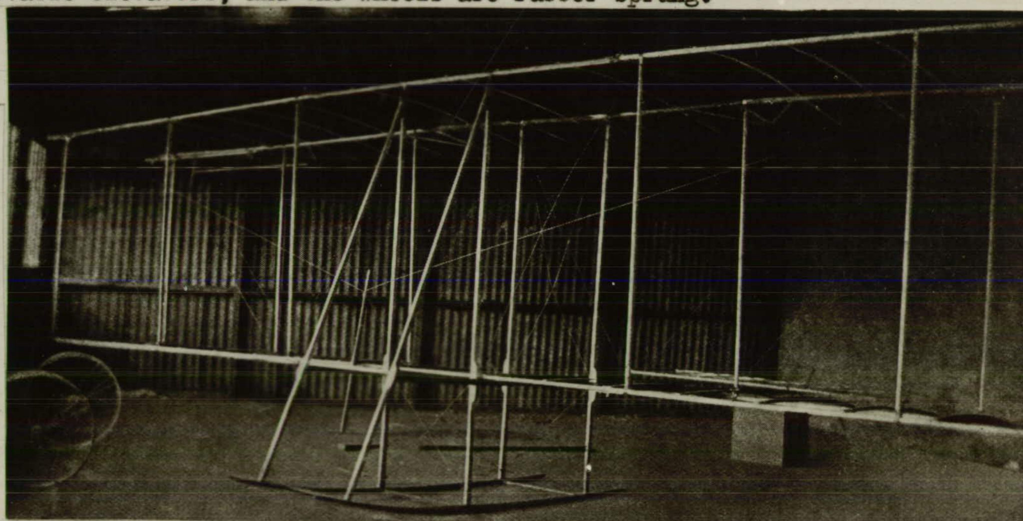
A front view of the glider showing the interconnected ailerons and tow ropes attached.

Plate 2



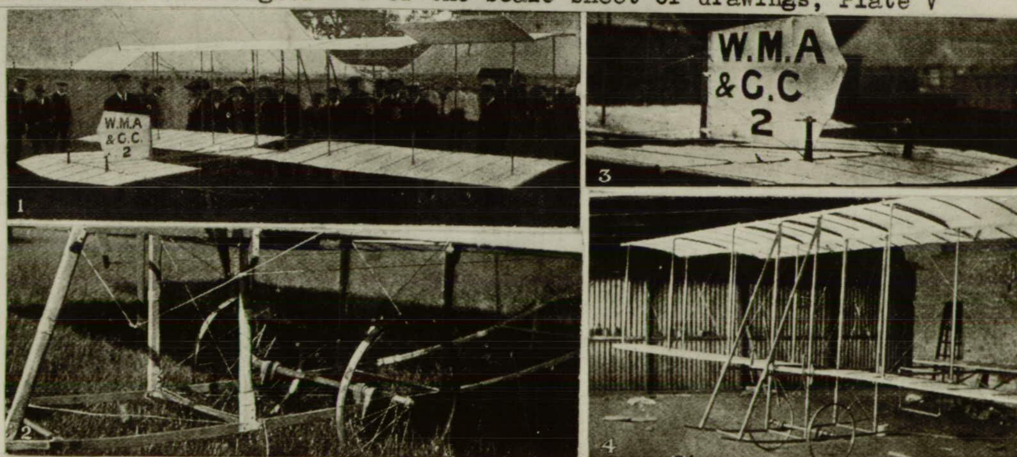
A general front view of the glider, showing the pilot's seat, control lever and landing gear. The span of the glider is 25 ft. and the weight 80 lb. The pilot's seat is adjustable fore and aft the tail has movable elevators, and the wheels are rubber sprung.

Plate 3



The glider nearing completion. A good idea of the construction, joints, bracing and general arrangement can be gathered from this illustration.
Compare this illustration with Figs.1 - 3 of the scale sheet of drawings, Plate V

Plate 4



(1) Three-quarter rear view of the glider. (2) Details of the landing gear showing the various joints, the suspension system, and the skids. (3) The tail unit, showing the kingposts and elevators, as well as the rudder, and (4) In process of final erection.